MDE Product Development Team
2nd Quarterly Report – FY 2011
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(Compiled and edited by S. Benjamin and B. Johnson)

Executive Summary

Task 11.5.1: Infrastructure support related to operational running of the RUC and NAM operational modeling systems.

- Problems noted in 2 cases by RUC users about 2m temperatures where RUC is showing snow cover. Investigations revealed that Rapid Refresh was giving much improved results in these cases.

Task 11.5.4 Develop, test, and implement Rapid Refresh configuration of the WRF modeling system.

- *The RR run at ESRL/GSD and the real-time parallel RR at EMC continue to show strong improvement for the Jan-Mar period over RUC for wind, temperature, RH, and height*
- *Precipitation verification indicates improvement for GSD RR over operational RUC at all thresholds.*
- *RUC-look-alike files from the RR continue to be produced to allow easy transition from RUC to the RR.*
- *ftp access continues for these grids from RR running at NCEP-EMC, evaluation of RR-NCEP-EMC continues.*
- *Planned date for RR implementation at NCEP - Sept 2011.*
- *Successful fix for deficient snow cover in RR*
- *Bug found, solved, and fixed (in early April) in WRF-DFI for cloud/hydrometeor/RH analysis.*

Task 11.5.5: Develop, test, and implement 3DVARs for RR and NAM

- Additional data sources now being used in GSI for RR (radial velocity from WSR-88D radars, TAMDAR moisture, WVSS aircraft moisture)
- RR cycling with binary format files benchmarked against netcdf cycling at GSD, changes ported to EMC parallel RR.
- Substantial number of additional aircraft observations (from Alaska Airlines) now available and being ingest by operational and experimental model assimilation systems including RR, RUC, and NAM. This is especially helpful for the hourly updated RR with its coverage of Alaska.
- Work continues to evaluate value added from radiance assimilation in RR (via GSI) including assessment of bias correction by channel for AMSU data.

Task 11.5.15: Develop methods for improved cloud/hydrometeor analysis in RR

- RR using GSI cloud analysis yielding significant improvement in short-range ceiling and visibility forecasts.
- Testing continued with WRF with variations on specification of hydrometeors

Task 11.5.24: Development/testing of HRRR

- HRRR 15-min grib2 files created and distributed to downstream users
- Many experiments completed from extensive 10-day July 2010 HRRR retrospective case study period with quantitative verification and qualitative assessment. Results indicated that switch to RR as HRRR parent (accomplished on 14 April 2011) should improve HRRR forecasts.
- Tests of 3-km DFI-radar assimilation in HRRR indicate forecast improvement for first few hours.
- Analysis of HRRR Convective Probability Forecasts (HCPF) from July 2010 period and creation of HRRR/HCPF overlay display concepts.

Task 11.5.1 Infrastructure Support Related to Operational running of the non-WRF Rapid Update Cycle System in NCEP Operations

ESRL/GSD

Operational RUC at NCEP has continued to run at 100% reliability since coordinate fix on 17 Nov 2010.

Reports were received by GSD from Storm Prediction Center and NWS offices on intermittently too cold 2m temp forecasts from RUC in certain regions. These cases were investigated – problems were confirmed and linked to snow cover areas. It was also found that the Rapid Refresh provided much better forecasts. This is discussed more under Task 5.4.

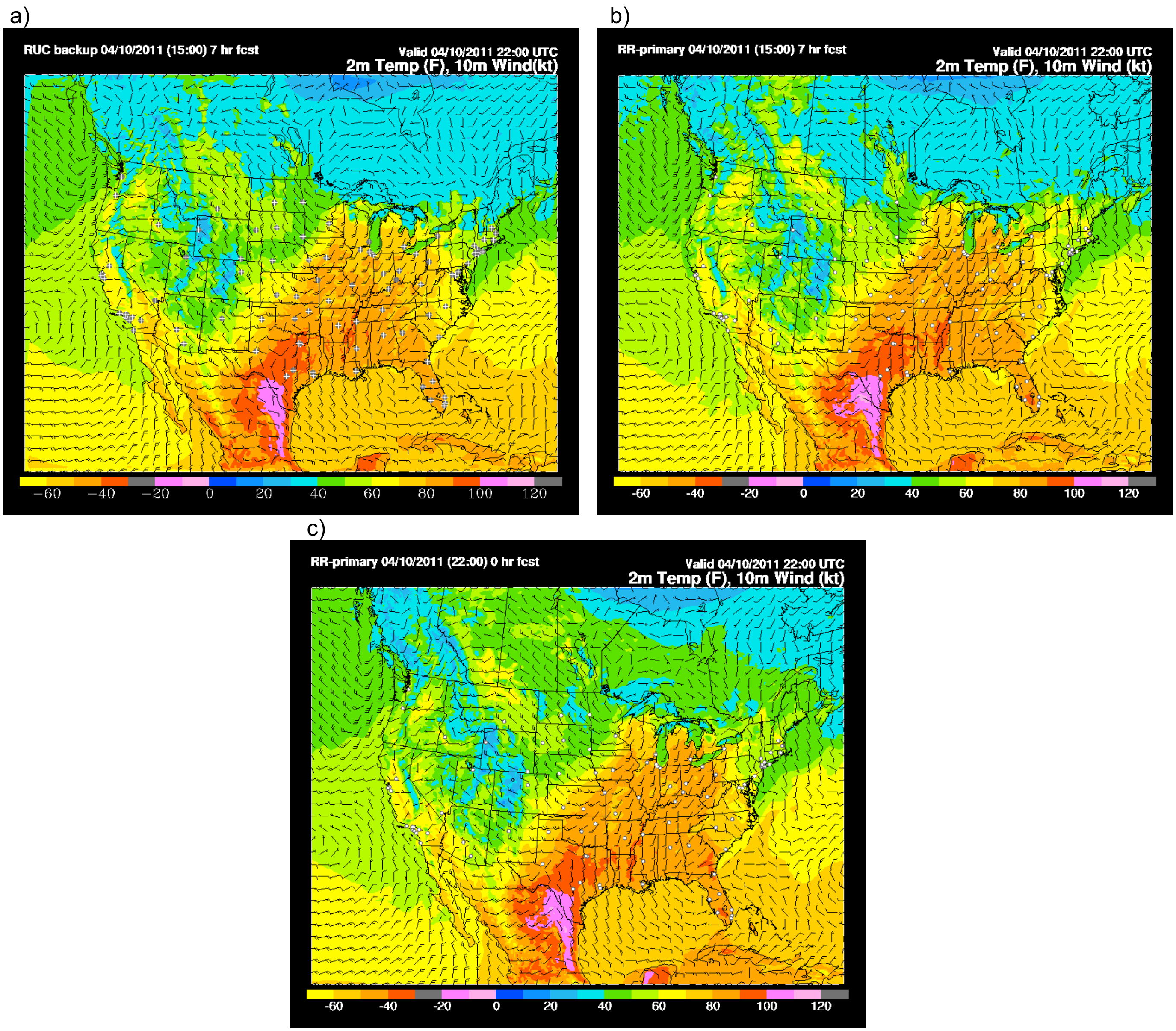


Figure 1. 2m temp 7h forecasts for a) RUC, b) Rapid Refresh, both valid 22z 10 April 2011. c) is the 0h (analysis) valid at the same time. Too cold temperatures were shown by the RUC over n. Wisconsin and in northern New England compared to the analysis (Fig. 1c). Much improved forecasts were shown in the Rapid Refresh (Fig. 1b).

ESRL continues to test a modification to the radar-DFI assimilation in which a cold pool effect is included by forcing cooling near the surface proportional to the maximum radar reflectivity in the column and also proportional to the degree of sub-saturation. This version has been running in the RUC-dev since 3 March, and is a prototype for similar future experiments in the Rapid Refresh/GSI.

ESRL continues to monitor operational RUC (and two ESRL versions of RUC with some differences in radar and cloud assimilation such as that described in the previous paragraph). Performance of the operational RUC is monitored at both ESRL and NCEP verification websites (see **http://ruc.noaa.gov/stats**). Inter-comparison of verification between the NCEP and ESRL versions of the RUC continue to be monitored by ESRL, also at **http://ruc.noaa.gov/stats**. Reminder: the backup RUC at ESRL is still currently used to initialize the HRRR (**http://rapidrefresh.noaa.gov/hrrr**), although the HRRR parent is on plan to be switched from the backup RUC to the ESRL Rapid Refresh in early April.

ESRL and NCEP/EMC also both tested use of a combined RUC/Rapid Refresh observational (prepBUFR) files, both successfully running the RUC pre-analysis program. These tests are preparing for eliminating one of the NCEP prepBUFR "dumps".

NCEP

Subtasks

11.5.1.1 Maintain hourly RUC runs and provide grids of SAV and AHP guidance products. (30 Sept 11)

No RUC crashes have occurred since 17 November 2010, due to the latest fix. (Manikin)

11.5.1.2 Provide vendors with gridded model data via Family of Services and the FAA Bulk Weather Data Telecommunications Gateway. (30 Sept 10)

NCEP maintained real-time availability of SAV and AIV guidance to all vendors from the operational hourly RUC on pressure surfaces on the 80-km AWIPS grid #211 via the NWS Family of Services (FOS) data feed and the FAA Bulk Weather Data Telecommunications Gateway (FBWDTG). (DiMego)

11.5.1.3 Provide full grids from RUC runs on NCEP and NWS/OPS servers. (30 Sept 10)

NCEP maintained real-time availability of full resolution gridded data from the operational RUC runs via anonymous ftp access via the NCEP server site at **ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/ruc/prod/** and at the NWS/OPS site at **ftp://tgftp.nws.noaa.gov/SL.us008001/ST.opnl/** in hourly directories named MT.ruc_CY.00 through MT.ruc_CY.23. This includes hourly BUFR soundings and output grids, which undergo no interpolation. Both sites now contain only grids in GRIB2 format **http://www.nco.ncep.noaa.gov/pmb/docs/GRIB1_to_GRIB2.shtml**. A limited set of fields from the RUC runs (and other NCEP models) can also be viewed at **http://www.nco.ncep.noaa.gov/pmb/nwprod/analysis/**. (DiMego)

11.5.1.4 Maintain access to model verification data. (30 Sept 10)

NCEP maintained its capability and provided access to routine verifications of the operational RUC analyses and forecasts. These include grid-to-station verifications versus rawinsonde, surface, aircraft, Profiler, and VAD data computed periodically at NCEP and accessible via NCEP's Mesoscale Modeling Branch (MMB) website: **http://www.emc.ncep.noaa.gov/mmb/research/meso.verf.html** (DiMego)

Deliverables

11.5.1E1 (30 September 2011) (Keyser, Liu)

Perform ingest, quality control and preparation of both existing and new observations in support of the operational RUC runs.

CURRENT EFFORTS: A major upgrade to the NCEP BUFR library (critical to all observational ingests), which impacts both the RUC and the NAM, was implemented on 25 January. The Florida and Georgia DOT mesonet providers remained down. The Wisconsin DOT mesonet provider has been down since 15 March. The Aberdeen PG mesonet provider returned to service on 1 March after being down for several months. Edwards AFB was added as a Mesonet provider on 7 February. There are 14 sites in this unrestricted network. The GOES-13 cloud and precipitable water retrievals have not been used since the switch to GOES-13 in April 2010. The NRL-based aircraft QC code package was submitted to NCO on 18 March for implementation late in FY11. This includes quality controlled high vertical-resolution aircraft profile data near airports, with the nearest METAR report providing the surface level. There was an NPN profiler outage on 25 January and again on 22 February. On 14 February more than 160 new (mostly North American) METAR sites began being decoded as the station table list was updated to agree with the MADIS list. (Keyser)

Work began in January on checking the differences in the effect of the new level-3 versus the old level-3 data on the analysis. The new level-3 data resulted in a slightly larger RMS compared to the old data. A method to graphically display the new Canadian radar data was developed. (Liu)

PLANNED EFFORTS: See also PLANNED EFFORTS listed under Task 10.5.17.E1 below for aircraft quality control issues. Implement NRL QC package. Obtain all TAMDAR data from AirDAT as alternate to MADIS feed and add airframe type and company code to allow the development of improved bias corrections. Continue work to resolve issues like late arrival of GOES 1x1 field-of-view cloud data and bringing in new SSM/IS data from DMSP F-16, F-17 and F-18 satellites to replace discontinued SSM/I products. (Keyser) Now that Canadian radar data are available at NCEP, it will be examined in detail to see if it can be used in the analysis. Continue checking the differences between radar level-2 data, level-2.5 data and level-3 data. (Liu)

PROBLEMS/ISSUES ENCOUNTERED OR ANTICIPATED: A severe backlog has developed in the implementation schedule on the NCEP computers.

INTERFACE WITH OTHER ORGANIZATIONS: NCO, NSSL.

UPDATES TO SCHEDULE: None.

11.5.1E2 (30 September 2011) (Manikin, ESRL)

Perform configuration management for RUC, including thorough documentation, and respond promptly to any code malfunctions or performance issues.

CURRENT EFFORTS: No RUC configuration changes were needed during the quarter. (Manikin, IBM and ESRL)

PLANNED EFFORTS: Monitor RUC performance.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS: NCO & ESRL.

UPDATES TO SCHEDULE: None.

11.5.1E3 (30 September 2011) (Manikin, ESRL)

Monitor RUC performance, respond to any problems detected by ESRL, NCEP, or any RUC users, diagnose cause, and develop solution to RUC software, test changes and coordinate with NCO on implementation.

CURRENT EFFORTS: No RUC crashes have occurred since 17 November 2010. (Manikin and NCO/PMB)

PLANNED EFFORTS: Continue monitoring.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: None.

INTERFACE WITH OTHER ORGANIZATIONS: NCO.

UPDATES TO SCHEDULE: All tasks and milestone/deliverables are complete.

Task 11.5.17 Infrastructure support for operational running of Rapid Refresh, North American Mesoscale, and HiResWindow (and future HRRR) at NCEP, including support for community WRF model

ESRL/GSD

Progress in Rapid Refresh development toward operational implementation at NCEP planned for Sept 2011 can be found under Task 5.4 report.

Regarding the WRF model, ESRL is testing variations to the MYNN PBL scheme inserting the alternative Bougeault-LaCarrere mixing length formulation, including discussions with the MYNN scheme developers. It is likely that this will be submitted to the WRF repository in the next few months.

NCEP

Subtasks

11.5.17.1 Maintain hourly RR and four/day North American Mesoscale runs and provide SAV and AHP guidance. (30 Sep 11)

Parallel tests of the NEMS/NMMB model in the EMC NAM parallel system continued on the CCS this quarter. During this quarter numerous changes were made and the change package finalized. In January the NMMB model was changed to gradually reduce dw/dt near the top of the model, by assuming attenuation of dw/dt in the top 15 hPa of the atmosphere (the top 1.5% of the mass of the atmosphere). The CFL-like noise problem occurs in the fire weather run since it has a high horizontal resolution combined with the high model top (2 mb), so the horizontal resolution near the top becomes higher than the vertical resolution, which is opposite to the situation lower in the atmosphere. In February two significant bugs were found in the NAM parallels. First, it was discovered that the NEMS-NMMB model code was not reading in the base (snow-free) albedo at the start of the NDAS, but instead reading the dynamic albedo and using it as the base albedo. This led to erroneously high albedo over shallow/patchy snow cover, which led to a cold air temperature bias over regions with shallow/patchy snow cover. A cold bias in soil temperatures were also seen that worsened with time. This bias started when the parallel NDAS began running digital filter initialization (DFI). It was determined that the physics state before the filter was run was not restored after the filter was finished, which led to colder soil temperatures. The DFI was then turned off in the parallels and the cycled NDAD land states were restarted from the operational NDAS. After the February bugs were solved at the beginning of March, the NAM codes were frozen and the 12 km control run (with no nests) was turned off. The previous “experimental” parallel, with nests, will continue to run with all the changes to be included in the NAM 2011Q3 implementation. (Rogers)

11.5.17.2 Maintain four/day HRW runs and provide SAV and AHP guidance. (30 Sep 11)

NCEP maintains 4/day runs of WRF-NMM at 4 km and WRF-ARW at 5 km when there are no hurricane runs. Five domains are run with three large domains – East-Central CONUS (00z & 12z), West-Central CONUS (06z) and Alaska (18z), and two small domains - Hawaii (00z & 12z) and Puerto Rico (06z &18z). (Pyle and NCO) A major upgrade to the HRW has been prepared and tested but is not scheduled for implementation until Q2 FY2011 (Mar 2011).

NCEP also maintains twice-per-day runs of six WRF-based members (3 running NMM and 3 running ARW) within the Short Range Ensemble Forecast (SREF) system. Aviation guidance prepared from the SREF is available from **http://www.emc.ncep.noaa.gov/mmb/SREF/SREF.html**, which now includes specific output for Alaska and Hawaii (eastern Pacific). (Du, Zhou)

11.5.17.3 Provide vendors with gridded model data via Family of Services and the FAA Bulk Weather Data Telecommunications Gateway. (30 Sep 11)

NCEP maintained real-time availability of SAV and AIV guidance to all vendors from the operational 4/day NAM on pressure surfaces on the 80-km AWIPS grid #211 via the NWS Family of Services (FOS) data feed and the FAA Bulk Weather Data Telecommunications Gateway (FBWDTG). Higher resolution grids (40-km grid #212 and 12-km grid #218) are also made available to FOS (and NOAAPORT) users. (DiMego)

11.5.17.4 Provide full grids from RR, NAM, and the HRW on NCEP and NWS/OPS servers. (30 Sept 11)

NCEP maintained real-time availability of full resolution gridded data from the operational 4/day NAM and HiResWindow (HRW) suite of WRF-NMM and WRF-ARW runs via anonymous ftp access via the NCEP server site at **ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/nam/prod/** (on numerous **grids**) and at the NWS/OPS site at **ftp://tgftp.nws.noaa.gov/SL.us008001/ST.opnl/**. At the NWS/OPS site, the NAM data are in 4/day directories named MT.nam_CY.*hh* where *hh*=00,06,12 or 18; while the HRW data are in 4/day directories named MT.hires_MR.*mmm*_CY.*hh* where *mmm*=arw or nmm and *hh*=00,06,12 or 18. This includes hourly BUFR soundings (NAM only) and output grids, which undergo little or no interpolation. Both sites now contain grids only in GRIB2 format, see **http://www.nco.ncep.noaa.gov/pmb/docs/GRIB1_to_GRIB2.shtml**. HRW output will become available to NWS forecast offices with AWIPS OP9. A limited set of fields from the NAM and HiResWindow (HRW) runs (and other NCEP models) can also be viewed at **http://www.nco.ncep.noaa.gov/pmb/nwprod/analysis/** (DiMego)

11.5.17.5 Maintain access to model verification data. (30 Sep 11)

NCEP maintained its capability and provided access to routine verifications of the operational RUC analyses and forecasts. These include grid-to-station verifications versus rawinsonde, surface, aircraft, Profiler, and VAD data computed periodically at NCEP and accessible via NCEP's Mesoscale Modeling Branch (MMB) website: **http://www.emc.ncep.noaa.gov/mmb/research/meso.verf.html** (DiMego)

For the NAM parallel, seasonal forecast-vs.-observation statistics (operational NAM versus NMMB control run), started with 1 June 2010 since the change with the biggest impact [multiple boundary rows] was put into the control run on 5/17/2010. Online summaries can be found by clicking **June-August 2010** and **September-November 2010** . Seasonal statistics for nests (operational NAM vs. NMMB parent vs. CONUS/Alaska nests), end date is when we switched from purely explicit convection to BMJ_DEV (light amount) can be found by clicking **12 July - 30 August 2010** . (Rogers, DiMego)

Deliverables

11.5.17.E1 30 September 2011 (Keyser, Liu)
Perform ingest, quality control and preparation of both existing and new observations in support of the operational RR, NAM, and HiResWindow runs.

CURRENT EFFORTS: See also the items reported under Task 11.5.1.E1. Since the RR has an extended domain including Alaska and some ocean areas, most of the following also apply to it. The Shemya radiosonde launch time problem has been corrected by Alaska region. All reporting Alaskan radiosondes are now available for at least the NAM runs. The problem of the NDAS not being able to process the complete set of APRX WeatherNet mesonet data due to a large number of duplicate reports from MADIS was corrected on 22 February with an NCO decoder change. All of the data still come in but with many fewer duplicate reports. Several erroneous AIREP aircraft waypoint locations were found, corrected and are currently being tested for implementation in April. The number of MDCRS-ACARS reports over North America increased by 1/3 after 28 March from the addition of observations from Alaska Airlines. This overflow caused an operational failure in the

0000 UTC 30 March GDAS ACARS QC code, which was immediately modified to handle the volume. These new Alaskan reports are being currently being rejected by GDAS due to erroneous data at the lowest (runway) level. GOES-13 radiances are monitored until the next NAM update. On 9 February the GOES spring eclipse season began with the usual gaps in data around 0600 UTC. All METOP-2 polar satellite data was lost for several hours on 21 and 24 January due to system issues, again on 27 January due to a fiber cable cut, and for several hours on 25 February due to a server failure at EUMETSAT. AQUA AIRS and AQUA MODIS data were very low or unavailable for 5 hours on 27 January due to a fiber cable cut. The NOAA-15 AMSU-B Level 1b radiances stopped on 28 March due to mechanical problems. NOAA-18 has on-going gyro issues that could lead to unusable products within 6 months. NESDIS engineers still need to conduct the last of three 24-hour tests where the corrupted navigation data will not be sent to NCEP. The following data types are monitored by the NAM-GSI: RASS virtual temperature profiles (NPN and MAP), MAP wind profiles below 400 mb, Mesonet mass data, AIRS AMSU-A radiances, NOAA-19 HIRS-4/AMSU-A/MHS radiances, METOP IASI radiances, ASCAT and WindSAT winds, and MDCRS moisture data. All but RASS are being tested in the NAM parallel. NAM/NDAS and RTMA PrepBUFR files are being generated in parallel with 50 km ASCAT and WindSat scatterometer wind data. Production NAM/NDAS dumps of METOP IASI radiances, GPS-RO data and SBUV-2 data are being created and dumps of RARS 1c radiances (begun 20 January) are being created in parallel and used in the NAM parallel.

NCEP generates experimental Rapid Refresh (RR) PrepBUFR files containing WindSat data (non-superob) and 50 km ASCAT for ESRL. These PrepBUFR files are now generated using the new NRL-based aircraft QC code and no longer flag MDCRS and TAMDAR moisture. ASCAT and WindSAT data dump time windows have been moved back 30 minutes to try to obtain more data for the RR. The AQUA AIRS and NOAA/METOP AMSU-A, AMSU-B, HIRS-3/4 and MHS, radiance dump time windows were moved from back 1 hour to try to obtain more data for the RR. RR dumps of Level 2 and expanded (time-window) Level 2.5/3 88D radial wind data, hourly lightning data, and GOES single-pixel cloud data from NASA/Langley (covering Alaska) are also being copied to a public ftp directory. These, along with early parallel dumps for 0000 and 1200 UTC, are being tested in ESRL's experimental RR runs and Geoff Manikin's RR parallel being run at NCEP. Langley cloud data were unavailable for parts of 13 and 25 January due to upstream issues. NCEP modified the Level 3 ("NIDS") radial wind decoder to handle a 12 January resolution change in these raw data by the NWS. EMC and GSD requested the Radar Operations Center (ROC) start their hourly processing of Level 2.5 88D data 25-30 minutes earlier so more data will arrive before the RR cutoff, as it's the only available radial wind data for Alaska. Adding a 5th hourly ingest run for Level 2 88D radar data is being discussed with NCO. The ROC has been contacted because the amount of Level 2 and Level 2.5 (locally-generated superobs) data being processed at NCEP has significantly decreased since December 2010. The Level 2.5 data are only being collected at 26 sites right now due to on-site software changes. The Level 2 data are only being collected at 140 sites (cause under investigation). NCEP/NCO implemented a decoder change on 15 March to handle the transition of Level 2 radar reports to dual-polarization next year. (Keyser)

Current Icing Potential (CIP) transition work continues. The codes to ingest Unisys radar basic reflectivity data into NCEP's version of the Current Icing Potential (CIP) algorithm were completed in January. Basic debugging of CIP was completed in February, but the result was not satisfactory so more debugging is required. Work on the WAFS has started, and the code to add Mountain Waves as a turbulence factor was finished in March. (Yali Mao)

PLANNED EFFORTS: Add the use of AIRS AMSU-A radiances to the next NAM-GSI update. Implement NRL quality control package (includes high vertical-resolution aircraft profile data near airports). Change PrepBUFR processing to add report sub-type information for development of bias corrections. Develop a "master use/reject-list" to control incoming data. Complete NAM and RR impact tests for TAMDAR (AirDAT feed); mesonet mass and roadway data, and new mesonet data feeds (including "hydro", "snow", modernized and SHEF COOP, UrbaNet, wind energy and late-arriving mesonet data); MDCRS aircraft moisture (including WVSSII on Southwest aircraft); new sources of mobile synoptic surface reports (over Greenland); TAMDAR aircraft moisture; NPN and MAP and European RASS virtual temperature profiles; JMA, Hong Kong, European, Canadian, MAP (below 400 mb), DOE and 6-minute NPN profiler winds; GOES 3.9 micron, GOES visible, and AVHRR POES satellite winds; hourly GOES IR and water vapor winds; WindSat and ASCAT scatterometer wind data (with later transition to new-science WindSat data); METOP IASI, and in the case of RR, METOP 1b, radiances; ozone from NOAA-series SBUV-2 and METOP GOME-2; GPS radio occultation data; SSM/IS wind speed and total precipitable water products; SSM/IS and TRMM/TMI rain rate; METEOSAT-9 IR and visible satellite winds; NOAA-19 AMSU-

A, MHS and HIRS-4 radiances; RARS 1c radiances (to fill gaps in NESDIS 1b ATOVS); VAD winds from QC'd NEXRAD Level 2 data; GOES-13 and -14 radiances and winds; 10 meter wind speed from JASON-1 and -2 satellite altimetry data; lightning data from BLM network over Alaska and W. Canada; "tcvitals" records for tropical cyclones. Maximize Alaska data retrievals (especially mesonet, aircraft and coastal surface). Add GSI events to NAM PrepBUFR files. Let GSI use the actual or estimated anemometer, barometer and thermometer heights on ships. Work with NCO to bring in new radar data sources (TDWR, Tail Doppler Radar from hurricane hunter P3 aircraft, Canadian, CASA, additional DOD sites). Examine possible use of mixed-satellite (Aqua and Terra) MODIS winds for better coverage and timeliness than the current MODIS winds. Obtain Wildfire Automated Biomass Burning Algorithm (WFABBA) products for use in NAM Fire Weather runs. (Keyser) Work on debugging CIP algorithm, now that dataset debugging is finished. (Mao)

PROBLEMS/ISSUES ENCOUNTERED OR ANTICIPATED: A severe backlog has developed in the implementation schedule on the NCEP computers.

INTERFACE WITH OTHER ORGANIZATIONS: ESRL/GSD & NCEP/NCO & NWS/Alaska Region & NESDIS

UPDATES TO SCHEDULE:

11.5.17.E2 30 September 2011 (Manikin, ESRL/GSD)

Perform configuration management for RR, including thorough documentation, and respond promptly to any code malfunctions or performance issues.

CURRENT EFFORTS: RR is not yet running in NCEP Production. No problems were detected during parallel testing this last quarter. (Manikin)

11.5.17.E3 30 September 2011 (Manikin, Pyle, Rogers, ESRL/GSD)

Monitor RR, NAM & HRW performance, respond to any problems detected by ESRL/GSD, NCEP, or any users, diagnose source/cause of the problem, develop solution, test changes and coordinate with NCO on implementation.

CURRENT EFFORTS: On March 29th, a significant change package for the HiresW system was implemented into NCEP operations. The package included an upgrade in the version of the WRF forecast model to v3.2, with both the ARW and NMM cores now using more conservative techniques for moisture advection. Forecast BUFR soundings are reintroduced to the HiresW, and a new hybrid ensemble system will generate high-resolution probabilistic guidance. Several new GRIB products of interest to severe weather, air quality, fire weather, and wind energy meteorologists are being added as well. The grid spacing will remain unchanged at 4.0 km for the WRF-NMM and 5.15 km for the WRF-ARW, but the Puerto Rico domain was expanded by about 50% to cover the island of Hispaniola and a new domain was added for Guam. (Pyle)

PLANNED EFFORTS: Monitor performance of the upgraded HiresW.

PROBLEMS/ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS:

UPDATES TO SCHEDULE: None.

NCAR

CURRENT EFFORTS: NCAR held a WRF tutorial on Jan. 31–Feb. 8, 2011. This covered WRF structure, operation, and related model components (e.g., Metgrid). Attendance was approximately 65. The next WRF tutorial at NCAR will be in July.

NCAR continued preparations for WRF major release V3.3. The Release Committee met regularly, the code was frozen, and friendly user versions were provided. At quarter's end, the release was in final preparation and came out on 7 April. Information on the release and a list of candidate features may be found at **http://www.mmm.ucar.edu/wrf/users/release_3.3.html**.

Jimy Dudhia of NCAR/MMM worked on various facets WRF physics development. For the V3.3 release, this included the following: (i) helping Wayne Angevine (NOAA ESRL) to resolve an instability issue with his new TEMF PBL scheme; (ii) adding the PBL height diagnostic for the Bougeault-Lacarrere PBL scheme (received from Alberto Martilli, CIEMAT, Spain); (iii) fixing the seasonal roughness length variation and run-off diagnostic in the Noah PBL (with the NCAR Noah team); (iv) ensuring that CESM physics works with nesting; (v) adding a fix from NCEP (Brad Ferrier) to enable Eta microphysics to use cloud tendencies from cumulus schemes; (vi) implementing code from Greg Thompson (NCAR RAL) to correctly initialize microphysics budget arrays for DFI applications; (vii) working with Ming Chen (NCAR MMM) to solve restart and OpenMP problems seen with the Grell shallow cumulus option; (viii) unifying TKE variables from different PBL schemes to a single name; (iv) updating the new Goddard scheme to comply better with WRF standards; (x) updating the WDM microphysics scheme with changes from the developers at YSU; (xi) adding upper boundary condition modifications from Steven Cavallo (NCAR/MMM) for the RRTMG radiation scheme; (xii) making minor modifications the Noah and Pleim-Xiu LSMs; and (xiii) implementing modifications from Brad Ferrier (NCEP) to allow the Eta microphysics scheme to use cumulus cloud tendencies properly.

Dudhia worked with Pedro Jimenez (Univ. Complutense Madrid, Spain; MMM visitor) to evaluate WRF surface wind biases in a large, multi-year, 2-km WRF simulations dataset. They have developed modifications to improve WRF surface wind forecasts in complex terrain based on topographic properties.

Dudhia worked with MMM visitor Dipu Sudhakar (Indian Institute of Tropical Meteorology). The work investigated the effects of dust on radiative heating, and they modified WRF code to diagnose the direct effect of aerosols on solar radiation.

Dudhia also worked with Ming Chen (NCAR/MMM) to test WRF cumulus schemes in the tropical West Pacific, including new ones for V3.3 (New Simplified Arakawa-Schubert (NSAS), Tiedtke, and Zhang-McFarlane). The testing was done to look at the schemes' heating profiles and rainfall characteristics, such as convective fraction v. threshold bins.

Dudhia developed prototype code to allow CO_2 to vary over the year in certain radiation schemes (RRTM longwave and Goddard shortwave). He also consulted with Stan Benjamin's group (in GSD) on how to force new moisture/cloud fields in their DFI applications where they affect model balance that can degrade forecast winds.

Lastly, Dudhia (and Joe Olson – ESRL/GSD) collaborated with MMM visitor Anna Fitch (Univ. of Bergen) on testing the effects of wind farms in WRF simulations. Final fixes were added for the inclusion of the wind farm parameterization for the V3.3 release.

PLANNED EFFORTS: The development and implementation of new physics for WRF will continue through FY11Q3.

UPDATES TO SCHEDULE: NONE

Task 11.5.4 Develop, test, implement, and improve the Rapid Refresh

ESRL/GSD
The implementation of the RR at ESRL continues to be planned to occur in August-September 2011.

Two serious intertwined issues with RR performance remaining at the beginning of the quarter appear to now be resolved.

The first of these, the matter of deficient snow cover (and consequent warm 2-m temperature bias in areas that are snow-covered in reality, but not in the RR), was worked on intensively during much of the quarter, and was discussed in the January and February monthly reports. A reasonably good solution, deemed acceptable by EMC, was devised and tested extensively at GSD via numerous short controlled retrospective experiments and by comparing performance of the real-time RRprimary and dev cycles at GSD. More on enhancements to the RUC-LSM treatment of snow motivated by this matter are discussed under Task 8.

This came prior to solution of the long-standing problem (reported in the October 2010 and FY11Q1 reports) of severe degradation of RR forecasts (especially winds) when the RUC procedure of restoring relative humidity coming out of the GSI analysis (including the cloud analysis component) after completion of the DFI was attempted in RR. Over the past several months we had tried various modifications of the RUC procedure in the RR to no avail. However, at the end of March, a breakthrough occurred when a decision was made to try the hydrostatic option in WRF. This gave no better results. However, in an effort to understand this disappointing result, it was discovered after an intensive search that the WRF-repository DFI code was not properly allowing for such a restoration. The fix was simple, and testing revealed none of the degradation we had seen before. So, in addition to restoring our trust in the WRF model itself, we now (as of 8 April) are truly following the same basic procedure as in the operational RUC in both the RRprimary and RRdev. We are also appreciative of the assistance provided by NCAR in helping us better understand the nature of this issue.

Fixing this long-standing bug also now produces improved (greater) snowfall during the first hour of the RR forecast, obviating the necessity for some of the earlier changes to deal with this matter. So, at this writing we believe the most egregious RR issues remaining at the beginning of the quarter are resolved.

The capability for use of binary (instead of NetCDF) output files from the model and GSI was completed in March and successfully tested at GSD and transferred to NCEP.

Radial winds continue to be assimilated into the RR, after the change back on 20 January when these observations became available sufficiently timely for inclusion in the RR 1-h cycles running at GSD.

Regarding UniPost, some changes were made in January to the originally RUC-based precipitation-type algorithm to reduce excessive areas described as being in mixed (rain/snow/sleet/freezing rain) precipitation type (also discussed briefly under Task 5.1). These improved the precipitation-type product for the late January precipitation events over the eastern US, and received approval by forecasters in these areas. The problem with erroneous GRIB2 files being produced for fields that are uniformly zero was also fixed in January. More recently, code was received from Greg Thompson of NCAR for calculating reflectivity consistently with the WRF v3.3 version of his microphysics code. This (or a compatible version of the v3.2-bugfix Thompson code now running in the RR) will be adapted for use in UniPost.

A change log on the ESRL primary RR 1h cycle is maintained at
http://ruc.noaa.gov/internal/RR_runs/RR_1h_info.txt.

Two abstracts providing updates and status of RR development were submitted to the 15th Conference on Aviation, Range and Aerospace Meteorology to be held in Los Angeles in August.

Subtasks

11.5.4.1 Ongoing (GSD, NCEP)
Ongoing evaluation of performance of real-time and retrospective runs of RR system for SAVs, AHPs

GSD:
The RR 1-h cycle at GSD and the real-time 1-h RR parallel cycle running at EMC continue to verify consistently better than the operational RUC upper-level variables (see Figs. 2 and 3). Also recent precipitation verification indicates improvement at all thresholds for the GSD RR compared to the operational RUC (see Fig. 4).
The substantial mid-upper troposphere moist bias noted in December was largely removed in late December by eliminating building of cloud based on satellite observations in the GSI cloud analysis. In fact, RR forecasts are now showing a substantial improvement over the operational RUC for mid-upper troposphere RH. The GSD RR-

primary 2-m temperature verification is satisfactory and generally as good or better than RUC except for being too warm in areas of deficient snow cover. Dew point at 2m is tending to run a little high except in dry areas of the interior Southwest, where dew points are running too dry.

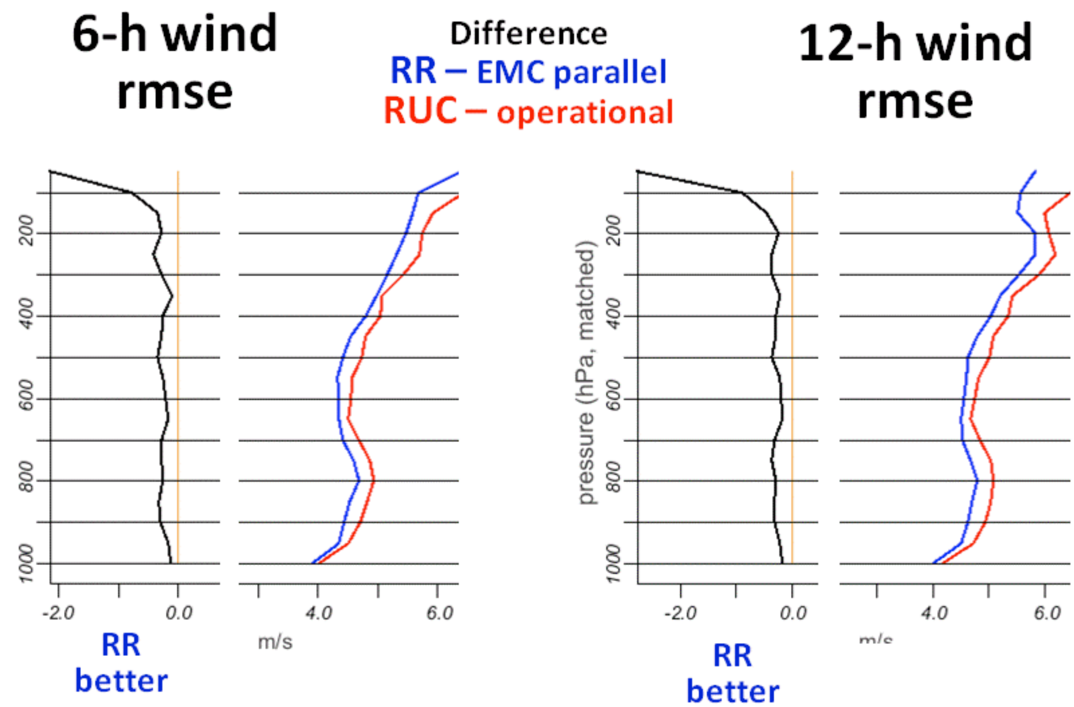


Figure 2. Verification of EMC real-time parallel Rapid Refresh vs. RUC (operational at NCEP) for 1 Feb 2011 – 10 Mar 2011 as a function of pressure level for 6-h wind (left), 12-h wind (right).

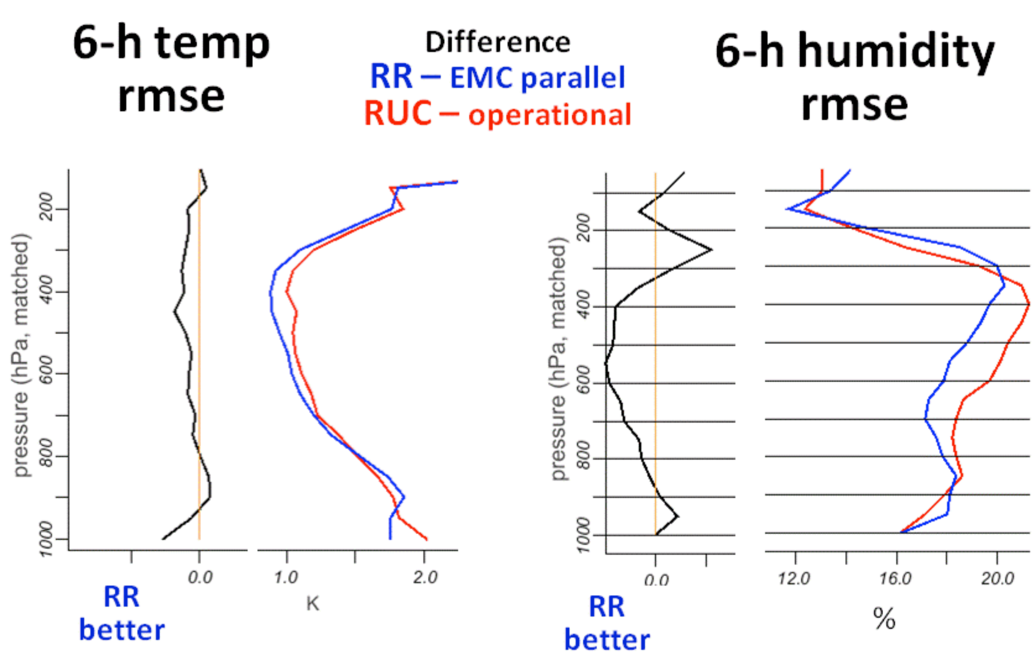


Figure 3. Verification of EMC real-time parallel Rapid Refresh vs. RUC (operational at NCEP) for 1 Feb 2011 – 10 Mar 2011 as a function of pressure level for 6-h temperature (left), 6-h relative humidity (right).

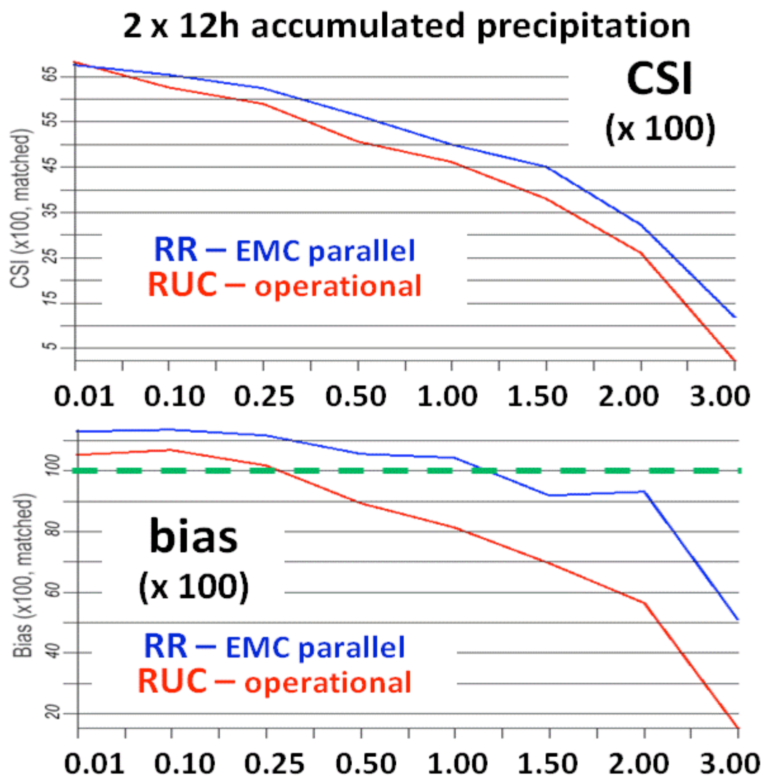


Figure 4. Verification of GSD real-time parallel Rapid Refresh vs. RUC (operational at NCEP) precipitation forecast skill for 25 Feb 2011 – 10 Mar 2011. Critical Success Index (x 100) in top panel and bias (x100) in bottom panel (2 x 12-h accumulations verified against 24-h CPC precipitation analysis.

NCEP
Subtasks

11.5.4.1 Ongoing evaluation of performance of real-time and retrospective runs of RR system for SAVs, AHPs. (30 Sept 2011)

The Rapid Refresh (RR) has been running stably in an EMC parallel environment with only minor code changes since December. The final change was made in March to improve model handling of snow cover, which had been causing some localized problems with temperatures. Statistical evaluation shows that the Rapid Refresh is now at least comparable to the RUC for most parameters, with significant improvement in the upper level wind and height fields. Grib1 and Grib2 files have been made available to the FAA, the NCEP service centers, and other RUC users on an ftp site and informal evaluation of the model analyses and forecasts is underway. Station time-series of BUFR data will be made available in April. Special test files were provided to several FAA groups to ensure a seamless transition when the RR replaces the RUC. RR implementation is currently scheduled for September. (Manikin)

11.5.4.2 1 Nov 2010 (GSD)

Solicit and respond to input from RR forecast users (e.g., FAA, AWC, SPC, NWS, other users), as well as AWRP RTs, on performance of Rapid Refresh.

pgrb, sgrb and bgrb files are now available in GRIB1 from the EMC test RR cycle output, and limited, though not unfavorable feedback has been received so far. Feedback from the other PDTs continues to be welcome.

Stan Benjamin, Tanya Smirnova and Joe Olson attended the Alaska Weather Symposium in Fairbanks in March to update the National Weather Service Alaska Region Science and Operations Officers (SOOs) on status of the Rapid Refresh, and to discuss other issues of particular interest to Alaska forecasters. Presentations were made on the overall RR configuration (Stan), on modifications made to the RUC land-surface model to improve WRF forecasts for the RR (Tanya), and on development work on the MYNN boundary-layer scheme that will likely be implemented in RR version 2 in FY12.

11.5.4.2 (NCEP)

Complete bringing ARW model code into compliance with than current version of NEMS, including successfully running forecasts and verifying integrity of ARW running under NEMS. (30 Sept 2011)

Work has not yet started. (Black, Manikin)

11.5.4.3 Start design of NARRE ARW physics ensembles. These will be derived either by varying parameters within the physics suite planned for the initial RR implementation, or by using different physics suites. Part of this subtask will be to do the experiments necessary to decide which of these alternatives gives the more useful ensemble diversity for aviation application, by means of real-time and retrospective testing on the RR domain. (30 Sept 2011)

The design work for using various physics suites to increase ensemble spread began in January. Dusan Jovic presented an initial plan for the physics configuration at an EMC Mesoscale Branch meeting in March. Binbin Zhou, to support aviation applications (similar to the experimental RUC Convective Probabilistic Forecast (RCPF) developed by Steve Weygandt at ESRL in 2005-2008), is also constructing a time-lagged North-America Rapid Refresh Ensemble (NARRE-TL). The NARRE-TL work will be presented at the AMS Aviation conference to be held in Los Angeles this August (Du).

Deliverables

11.5.4.E1 20 Dec 2010 (GSD)
Report on Rapid Refresh status and plans to NCEP Operational Model Production Suite Review meeting.

Complete. Presentation available at **http://www.emc.ncep.noaa.gov/annualreviews/2010Review/**

11.5.4E1a (28 February 2010) (Manikin)

Update documentation for operational Rapid Refresh.

CURRENT EFFORTS: Rapid Refresh versions of the special files with WMO headers currently used by the FAA were provided for evaluation purposes. Grib1 and Grib2 files have been made available to the FAA, the NCEP service centers, and other RUC users on an ftp site and informal evaluation of the model analyses and forecasts is underway.

Experimental Rapid Refresh grids from the EMC parallel run are available at **ftp://ftp.emc.ncep.noaa.gov/mmb/mmbpll/rap**. Inside the directory for each date, you will find the following for each cycle:

13 km grids covering current RUC domain w/ data on native levels (awp130bgrb)*
20 km grids covering current RUC domain w/ data on native levels (awp252bgrb)
13 km grids covering current RUC domain w/ data on pressure levels (awp130pgrb)*
20 km grids covering current RUC domain w/ data on pressure levels (awp252pgrb)

11 km grids covering Alaska (awp242)
32 km grids covering the full domain (awip32)
(Manikin)

PLANNED EFFORTS: Provide RR station time-series of BUFR data for user evaluation.

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS: NCO, ESRL & FAA.

UPDATES TO SCHEDULE:

11.5.4E2 (31 August 2010) (Manikin)

Code transferred to EMC for Rapid Refresh upgrade change package to be implemented in early FY12.

CURRENT EFFORTS: The final change was made in March to improve model handling of snow cover, which had been causing some localized problems with temperatures. Statistical evaluation shows that the Rapid Refresh is now at least comparable to the RUC for most parameters, with significant improvement in the upper level wind and height fields. (Manikin)

PLANNED EFFORTS: Continue to run the RR in an EMC parallel environment and evaluate for implementation. RR implementation is currently scheduled for September. (Manikin)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED:

INTERFACE WITH OTHER ORGANIZATIONS: ESRL.

UPDATES TO SCHEDULE:

Task 11.5.5 Develop, test, and implement improvements to the operational data assimilation supporting Rapid Refresh and North American Mesoscale runs

ESRL/GSD

As discussed under Task 5.4, the Rapid Refresh system has been running in real-time parallel configuration at NCEP and 2 real-time versions have been running at ESRL/GSD. In addition, a carefully controlled multi-day retrospective test period cases are available and have been used extensively during the past 6 mos. RR upper-air forecast verification statistics (comparisons against rawinsondes) have consistently shown RR superiority compared to the RUC, since the final changes to the background error covariance specification in the fall 2010. Principal changes to the analysis this quarter included: 1) the addition of two additional observation types (both used in the RUC) into the RR. These observations are TAMDAR/WVSS aircraft moisture and PBL profiler winds, 2) the addition of GSI code to use GSD-generated aircraft observation QC (specific to tail number / MDCRS number -- both can be used in the prepbufr file), 3) improvements to the time availability of radar radial velocity data to allow these observations to be included in the GSI for RR at ESRL, and 4) testing, benchmarking, and transfer to NCEP of the code to do the RR cycle with binary I/O for the RR runs. In addition to these observation-related changes, a significant increase in the number and coverage of aircraft observations available to the operational and real-time parallel models (including the RUC, NAM, and RR) occurred in early April with the addition of Alaska Airlines data.

In addition to these observation-related changes, a change was made in the RR to increase the magnitude of the latent heating specification during the DFI-based radar reflectivity assimilation. This change improved RR precipitation skill scores as well as downstream RR-HRRR reflectivity verification scores, with no degradation in other RR verification aspects (upper-air verification, etc.). As noted under Task 5.4, a issue with the WRF DFI was resolved, such that after the radar-DFI step, hydrometeors and the water vapor field can be restored to the pre-DFI (post-GSI analysis) values. This is a significant improvement that now brings the RR cloud analysis to consistency with the RUC formulation. Finally, Ming Hu completed tests to benchmark the performance of the GSD RR system cycling with binary I/O compared to netcdf I/O and is porting these changes to the EMC parallel RR.

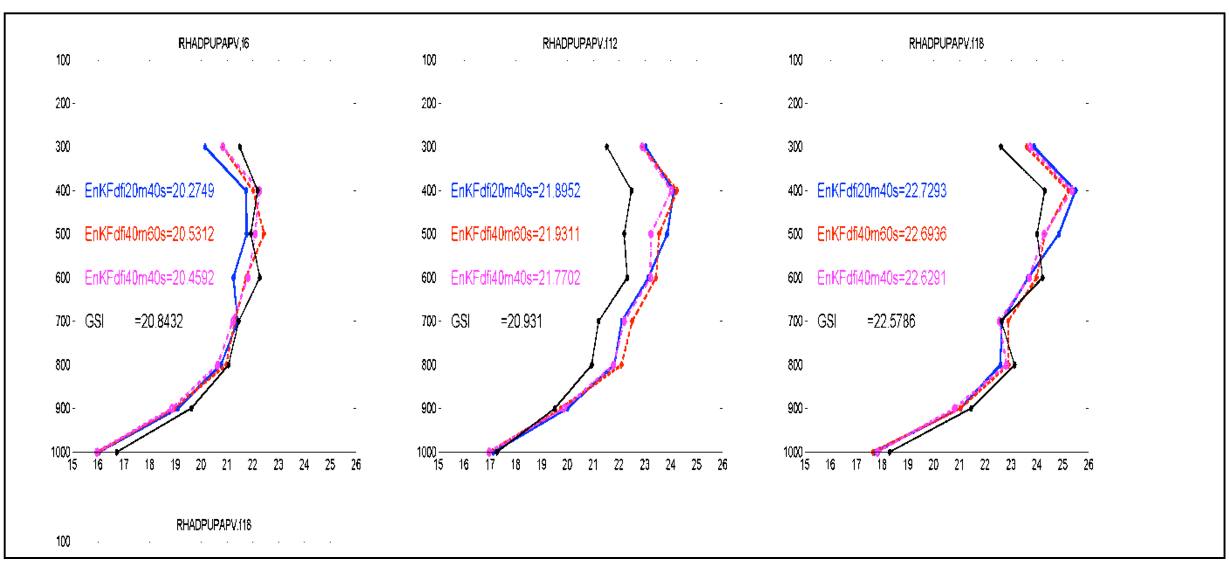
Additional work has focused on evaluation of the satellite radiance data assimilation within GSI for the Rapid Refresh. Evaluation of sample AIRS BUFR format data files (provided from the NCEP observation feed for the RR 1-h cycle) shows very limited coverage, presumably because of the severe data cutoff restrictions for the hourly cycled RR. One possible way to optimize the assimilation of these data would be to only use them during the partial cycling period (which with an optimal run configuration, allows for a longer data cutoff period). Working with historical GDAS AIRS data files, Haidao Lin is creating hourly cycle compatible AIRS data files from the 6-h GDAS AIRS files (extracting data from the GDAS and sometimes concatenating extracted data). These files will then be used for experiments to evaluate the impact from different AIRS assimilation strategies.

CAPS

During the last quarter, major efforts were focused on tuning the EnKF data assimilation configurations to reduce the errors of ensuing forecasts. A set of experiments have been conducted and categorized into two groups: the first group was to see the forecast errors corresponding to the vertical and varied horizontal de-correlation scale; and the second was to see forecast errors corresponding to the configuration of DFI, which is to reduce the model noise level. EnKF-based forecasts were found to be much more noisy than GSI-based forecasts when using the same DFI configuration.

Results were further verified and compared through Model Evaluation Tools (MET). In the last year, we used the GSI diagnostic files to calculate the forecast innovation. But due to quality control within the GSI, different sets of observations may be involved in the verification of different forecasts. These differences would be enlarged when verifying longer forecasts and would lead to unclear comparison between GSI and EnKF-based forecasts. In MET, we used ADPSFC and SFCSHP for the surface variables verification and ADPUPA for the upper air variables. For the surface verification, since observation data were available within the 3-h interval, 66 forecast samples were collected during this testing period. For the upper air verification, the ADPUPA are only available at 00, 12Z, therefore, 16 forecast samples were collected. Figure 5 shows the upper air verification result of relative humidity and X-component wind. In general, the EnKF-based forecast errors of relative humidity were smaller than GSI-based forecasts at 6h lead-time. At 12h lead-time, the EnKF performed worse than the GSI.

However, at 18h lead-time, the EnKF performed better than GSI at lower levels, but worse at upper levels. Work is being done to understand why at 12h lead-time as compared to other lead times, the EnKF showed a larger error than GSI. For the u-component wind, the EnKF-based forecast errors were comparable with the GSI-based in the lower level but worse in the upper level. In addition, 12h-long 13 km forecasts initialized by 00 and 12 UTC 40-km GSI and EnKF analyses were produced for the testing period. It was found that the precipitation forecasts initialized from EnKF analyses were better than the one initialized from GSI when comparing the rain band position, intensity and as well as structure from the forecasts with the NCEP Stage IV precipitation data. Moreover, the hourly precipitation GSS scores during this testing period also showed that the EnKF precipitation forecasts were better than GSI (not shown).



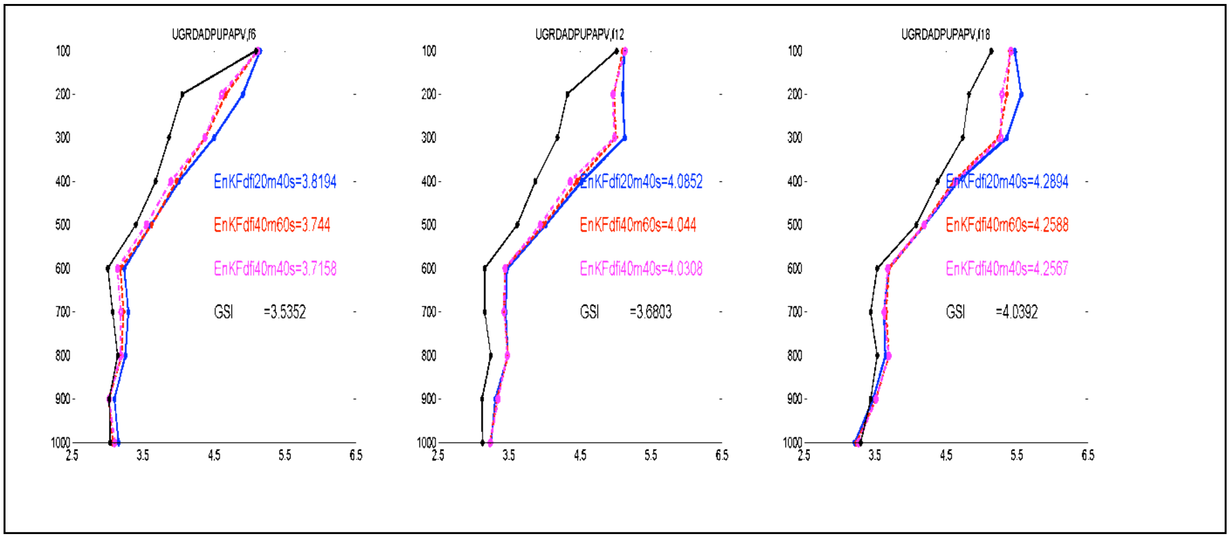


Fig.5. The averaged RMS forecast errors of forecasts initialized by GSI and EnKF analyses, verified against ADPUPA (upper-air observations). The first row is relative humidity and the second is u-component wind. The columns are the 6-h, 12-h and 18-h forecast errors, respectively.

Efforts continued to improve the single-observation increment structure for GSI-based hybrid Var-EnKF and pure EnKF. In February, we obtained the latest GSI package that contains the latest hybrid capabilities. Work was focused on the single observation test with the latest hybrid. Experiments that aimed in examining the hybrid parameters, such as weight given to static background (beta1_in), the horizontal localization correlation length (s_ens_h) and the vertical localization length scale (s_ens_v) in the unit of grids have been conducted. The increment of one observation test suggested those parameters worked well. However, when vertical localization length scale in the unit of ln(p) was used, the hybrid did not run and we found it was because there was miscalculation of the three dimensional pressure field in the regional mode of the hybrid. Therefore, we fixed this bug by calculating 3-D pressure using the same algorithm as regional GSI. In this algorithm, the ensemble mean of the surface pressure was used. Two experiments employing GSI 3DVAR, pure EnKF and hybrid Var-EnKF have been carried out at different times to test this modification. The first one was analyzed at the initial cycle, and the second was at 00UTC May 13 2010, which was after 5 days of the EnKF cycles. For all these experiments, we placed a single temperature observation with a 1˚C innovation at 700 hPa over Norman, OK.

Fig. 6 is the distribution of temperature increments as a function of height of the first experiment. Horizontal localization and vertical localization were set to 410 km and 0.3 respectively for GSI-based Var-EnKF hybrid. The increment distribution of the hybrid exhibited similar behavior as the pure EnKF, but the magnitude of the increment of the hybrid is smaller than the EnKF at levels below the observation. This difference might be caused by different vertical localization method: while the pure EnKF employed Gaspari-Cohn function for the vertical localization, the hybrid used recursive filter. Fig.3 shows the temperature increment distribution of the second experiment. As Fig.2, the pure EnKF and hybrid EnKF had similar increment distributions as a function of height, but the magnitude differences between the EnKF and the hybrid were enlarged, especially at low level. The increment of the hybrid was significant smaller than pure EnKF. Work is ongoing to examine the difference of the EnKF and hybrid in vertical covariance localization.

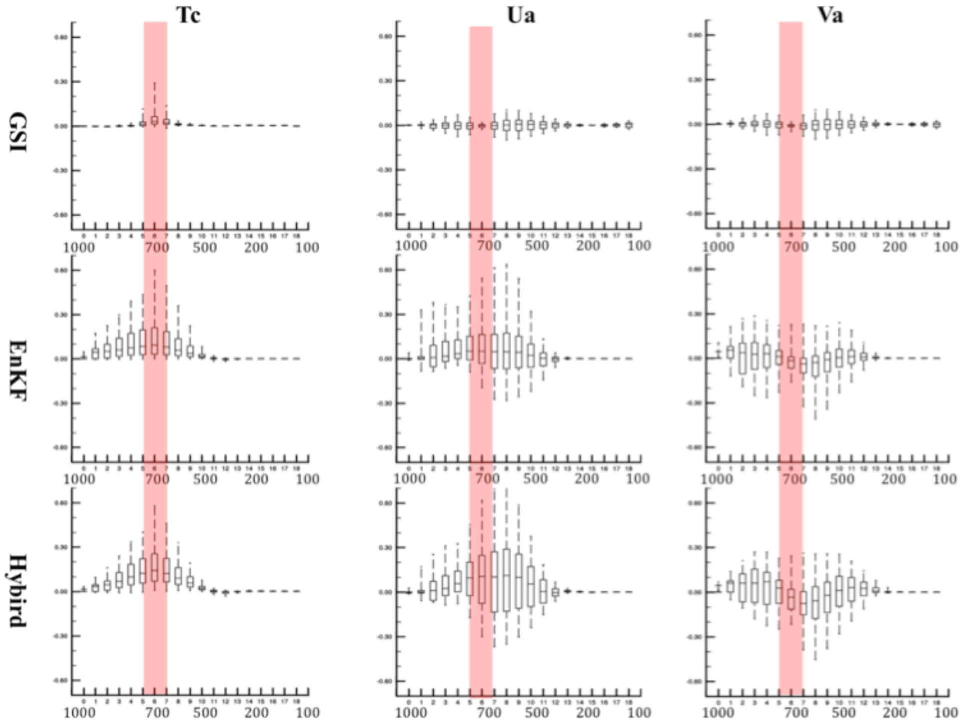


Fig 6. Box plots of Tc (temperature in centigrade), Ua (u-component wind) and Va (v-component wind) increment as a function of height employing GSI, pure EnKF and hybrid at 00 UTC May 08, 2010. The bottom and top of the box is 25th and 75th percentile respectively, the band near the middle of the box is 50th percentile, and ends of whiskers are the minimum and maximum of data. The x-axis is pressure in hPa.

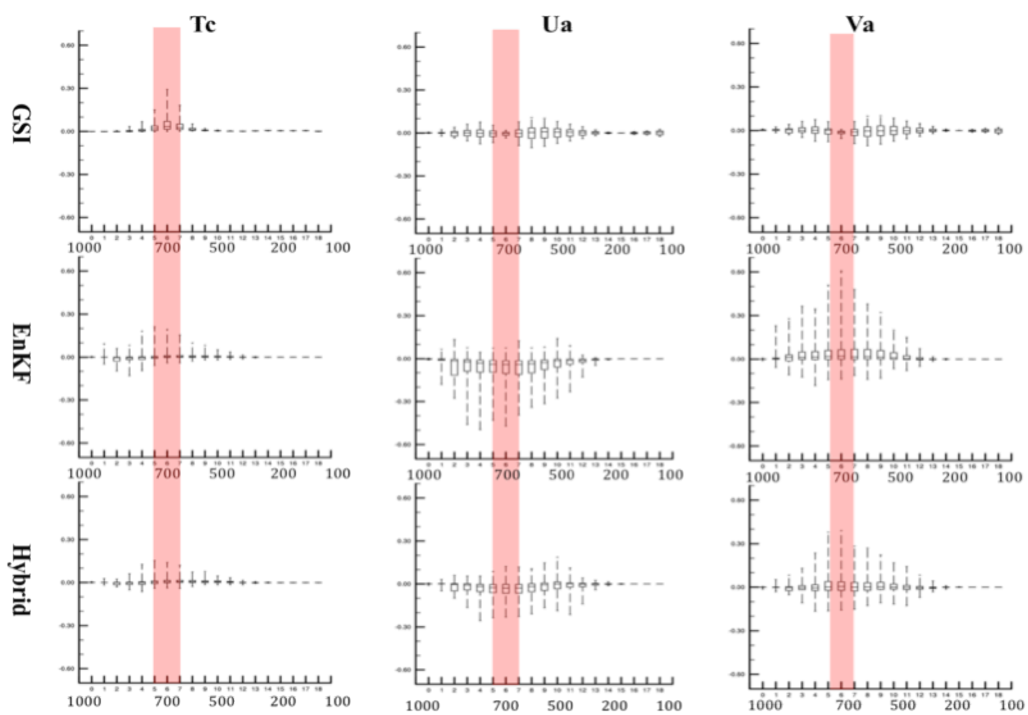


Fig 7. The same as Fig. 6, except at 00 UTC May 13, 2010

NCEP

Subtasks

11.5.5.1 Refine the radial velocity analysis component of GSI and determine the optimal decorrelation scales for different analysis passes. (30 Nov 11)

NCEP started receiving new high-resolution level-3 radar data in January, and work began on checking the differences in the effect of the new level-3 versus the old level-3 data on the analysis. The new level-3 data resulted in a slightly larger RMS compared to the old data. (Liu)

11.5.5.3 Report on testing of 2DVAR GSI assimilation of high spatial and temporal mesonet surface data using analysis grids with 2.5-km resolution. (31 May 11)

A manuscript titled "The Real-Time Mesoscale Analysis at NOAA's National Centers for Environmental Prediction: Current Status and Development" has been accepted for publication in the AMS journal Weather and Forecasting. Work to improve the amplitude of the Lanczos-based estimate of the GSI-2DVar analysis error with the help of cross-validation statistics has been completed. A 3-km resolution Alaska RTMA (to replace the current 6-km system) has been built and tested, and work on building a 1.5-km resolution Juneau-Alaska system is ongoing. (Pondeca)

The following three analysis variables: Planetary boundary layer height, wind gust, and visibility have been added to the GSI-2DVar option. (Yanqiu Zhu)

11.5.5.4 Adapt Desrozier et al. techniques to RR and apply to refine observational error and background error covariance estimates within the GSI. (30 Jun 11)
Not worked on this quarter. (Wu)

11.5.5.5 If authorized by NCEP Director, implement initialization of HiResWindow runs using CAPS/Shun Liu improved techniques for radial velocity analysis in GSI together with Diabatic Digital Filter use of 88D reflectivity Mosaic. (31 Jul 11)

GSI codes were modified to use the observation subtype to discriminate between level-2, level-2.5 and level-3 radial wind observations in the regional GSI analysis. Because HiResWindow codes have been frozen for the 29 March 2011 implementation, this work will target the next upgrade in 2012. (Liu)

11.5.5.6 Based on case-study testing and refinement of the research quality code, deliver result in an ‘experimental’ code for an upgrade package (e.g. strong constraint, improved satellite channel bias correction, improved use of WSR-88D radial wind and/or satellite radiances and/or retuned covariances to the GSI for FY2011 change package to the NAM. (31 Jul 11)

Work continued to fix the “non-meteorological” (both saturated and unstable) profiles occasionally generated by the NAM’s GSI analysis. The resulting spin-down in the model has a negative impact on the subsequent forecasts. The reason that these profiles exist was that the analysis increments were spread in the vertical without considering the structure of the background. This is exacerbated when there is a large vertical separation between reporting levels in a radiosonde report. In order to adjust the background profiles toward the rawinsonde observations, intermediate ‘reporting levels’ were added between the reported levels for both temperature and humidity. This is entirely consistent with radiosonde reporting practices that limit reporting to “significant levels” where the vertical traces of temperature and humidity deviate from a straight line on a tephigram (DiMego). These extra levels did not slow down the 3DVAR convergence and had little effect on the analysis except in the local area where the data were added. The resulting analysis was closer to the observed rawinsondes and non-meteorological profiles were less likely to occur. This work was presented at a March Mesoscale branch meeting. (Wu)

Deliverables

11.5.5.E1 15 Sep 2011 (Manikin)
Pending EMC, and NCEP Center initial recommendations, Requests for Change (RFCs) are filed to submit GSI code as part of late 2011 upgrade for Rapid Refresh software to NCO.

CURRENT EFFORTS: GSI codes were modified to discriminate between level-2, level-2.5 and level-3 radial wind observations in the regional GSI analysis. To eliminate redundant radial wind observations from the CONUS regional analysis, codes will be modified to not use level-2.5 radial winds in the CONUS. Level-2.5 data will be only used in Alaska since there is no level-2 data available in Alaska. The observation errors for level-3 observations in the CONUS were increased to reduce the impact of the level-3 data on the analysis. The reflectivity analysis package was updated to include the method of calculating reflectivity used in WRF-post, along with NRL's reflectivity assimilation and reflectivity simulation codes. A limited comparison between the simulated reflectivity from the current method and NRL's method was done. The current method's reflectivity looks better than that from NRL's method based on one case. Based on this analysis, the latent heat was calculated and the adjusted temperature appeared reasonable based on this one case. (Liu)

PLANNED EFFORTS: Continue checking the differences between radar level-2 data, level-2.5 data and level-3 data. Compare the old level-3 data against the new (high resolution) level-3 data. (Liu)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: A severe backlog has developed in the implementation schedule on the NCEP computers.

INTERFACE WITH OTHER ORGANIZATIONS: NCO

UPDATES TO SCHEDULE: DELAYED INTO 2011. None.

11.5.5.E2 30 Sep 2011 (Wu, Parrish, Rogers)
Subject to NCEP Director approval implement NEMS/NMMB version of GSI (e.g. strong constraint, revised bkgs+obs errors) in NAM/NDAS.

CURRENT EFFORTS: Three new emergency fixes to the analysis system were included in the NEMS/NMMB GSI. To avoid redundant usage of radar data the level-2.5 and level-3 radial winds were limited and given reduced weight. This change resulted in little impact on forecasts. The grid relative winds in the diagnosis files were replaced with earth relative wind information, which had no impact on the resulting analysis. The NOAA-15 AMSU-B radiances were turned off because of an antenna scan motor anomaly that made the data unusable. (Wu, Parrish, Rogers, Liu)

No work was done this quarter on the strong constraint. Work was done on a hybrid ensemble GSI application for radar reflectivity assimilation using the 1.33km NMMB nest. The hybrid ensemble part of GSI was updated to be consistent with the generalized control variable capability in the static background part of GSI. (Parrish)

GSD's cloud analysis package in GSI was modified so that it can be used by NMMB. GSI codes were modified so the NMMB can use this data also. Adjusted temperature from GSD's cloud analysis package was compared with that from NRL's method. In general, GSD's package only gives positive temperature increments, while NRL's package gives both positive and negative temperature increments. (Liu)

PLANNED EFFORTS: Continue NMM/NDAS parallel testing. (Rogers) Run tests in the NDAS parallel with full 84hr forecasts and verification. (Wu) Complete generalized control variable change for hybrid ensemble part of GSI. Fix an adjoint bug in the dual resolution capability to reduce run time. (Parrish). Continue work to add NMMB generated ensemble input to the NMMB hybrid GSI, initially for use in assimilation of radar reflectivity at storm scale resolution. (Parrish) Run forecast experiments with modified temperatures based GSD's cloud analysis or NRL's reflectivity analysis. (Liu)

PROBLEMS / ISSUES ENCOUNTERED OR ANTICIPATED: A severe backlog has developed in the implementation schedule on the NCEP computers.

INTERFACE WITH OTHER ORGANIZATIONS: GSD, NCO

UPDATES TO SCHEDULE:

Task 11.5.8 Improve physical processes in the WRF (RR and HRRR) and NAM models, especially including those that affect aircraft icing.

GSD

Several modifications were made by Tanya Smirnova to the RR version of the RUC-LSM (RUC Land-Surface Model) to improve snowmelt and low-level temperature forecasts over snow. The more important ones include the following. The albedo over snow is now a function of skin temperature, being reduced for skin temperatures warmer than -10C, but with a lower limit of 0.5 for 100% snow cover. Further, the maximum snow depth for which albedo is decreased in order to account for partial snow cover is increased. Specification of albedo as a function of temperature for snow on top of ice is also changed. All these albedo dependencies on temperature and snow depth are made subject to the condition that fresh snow is not falling.

Comparison testing of three versions of the Thompson microphysics (v3.2, v3.2-bugfix, and v3.3) was made during the quarter. Most of this was focused on the HRRR forecasts of convection, where the differences in convection forecasts are appreciable in some cases. A decision was made to not use the v3.2 version, which has a few known bugs, in favor of v3.2-bugfix. Experiments comparing v3.3 and v3.2-bugfix in the HRRR show nearly identical results in terms of location and character of the resolved convective elements, except that reflectivity cores are notably smaller in size using v3.3. (All these reflectivity results are using the RUC reflectivity diagnostic based on the December 2003 version of the old Thompson microphysics used in RUC. This will be updated shortly.) The RR continues to run with v3.2-bugfix.
During the quarter, Joe Olson continued developing and testing revisions to the Mellor-Yamada-Nakanishi-Niino PBL scheme. Further robustness was added by eliminating impacts of the surface layer at altitudes well above the boundary-layer height and replacing the existing MYNN formulation with the Bougeault-LaCarrere formulation for the dominant mixing length in the free atmosphere. Further, work toward improving the MYNN surface layer by modifying treatment of the thermal roughness length and making other modifications was also tested. Overall, in individual case studies the mods to the MYNN continue to show good promise of improving wind forecasts in the boundary layer without degrading temperature forecasts and without causing poorer wind forecasts aloft. A retrospective RR test to compare performance of this scheme to the current MYJ is still planned, but during the quarter was eclipsed by more urgent concerns (Task 4).

The use of this modified version of the MYNN scheme is being considered for the Rapid Refresh *after* its initial implementation at NCEP later this year. It is also being considered for eventual application in the HRRR.

NCAR

Subtasks:

11.5.8.1 Oct '10
Start to evaluate the relatively performance of new microphysics and PBL schemes used in the physics-perturbation-only 4-km CONUS-scale forecasts from CAPS spring forecast experiment.

11.5.8.2a Apr '11
Continue testing newly implemented coupled aerosol-microphysics scheme in case studies and perform sensitivity analyses.

11.5.8.2b May '11
Determine the best method for including aerosols into HRRR's initial analysis and boundary conditions so they are available to the microphysics scheme.

Deliverables

11.5.8E3 Sep '11

Deliver an improved ice nuclei tracking scheme in the two-moment microphysics scheme to ESRL for real-time testing in the WRF Rapid Refresh.

CURRENT EFFORTS:
Trude Eidhammer continued to develop and test the new aerosol scheme with a focus on ice nucleation and incorporation of the scheme into the operation Thompson microphysics. This month Trude worked on the dry deposition of dust due to turbulent mixing. Simulation runs indicated that a large amount of dust at surface levels were carried long distances, especially in dry conditions. Previous, only gravitation settling was included, but for the aerosol size distribution assumed in our module, the removal of aerosols due to interactions with the surface also has an important component. Still, the wet deposition of aerosols in the size range we use in the module is more efficient than dry deposition.

PLANNED EFFORTS: Continue developing and testing the new aerosol scheme.

PROBLEMS/ISSUES ENCOUNTERED OR ANTICIPATED: None

INTERFACE WITH OTHER ORGANIZATIONS: GSD

UPDATES TO SCHEDULE: None

Task 11.5.15 Develop improved methods of cloud and moisture analysis for use in the Rapid Refresh and NAM Modeling Systems.

GSD
As discussed under Task 5.4, a key breakthrough was recently made on a longstanding RR issue that affected the cloud and moisture analysis. This fix allows the full RUC cloud analysis capability to be brought into the RR. Previously a final step (after the radar DFI), in which the hydrometeor and water vapor fields were restored to their pre-DFI (post-GSI analysis values), were not able to be completed for the RR. When this step was attempted for the RR, significant degradation of the upper-level forecasts resulted. Encouragingly, even without this step (which was important for the RUC ceiling forecasts), the RR ceiling forecasts were quite good. Strong detective work by Tanya Smirnova traced the problem to a change in the order of certain ARW modules in the repository version of the WRF-DFI, allowing it to be easily resolved. This is a significant improvement that now brings the RR cloud analysis to full consistency with the RUC formulation.

Additional work on the RR radar assimilation algorithm is ongoing. Ming Hu has coded and tested a modification in GSI to the calculation of the radar-reflectivity-based temperature tendency (used later in the ARW model for the RR reflectivity assimilation, which also impacts the HRRR). The change is to calculate the boundary layer (BL) height and to not specify a radar-derived temperature tendency in the boundary layer (note: this temperature tendency may be zero in no echo regions beneath storms). This will prevent heating in the boundary layer (noted previously by forecasters as being a problem in deep mixed layer environments) and also allow a more natural evolution of potential convection-related cold pools. (This refinement in radar assimilation using BL height was developed in 2010 with the RUC.)

The second effect is possibly quite important for thunderstorm evolution in the RR and affecting the HRRR. Presently, low-level cold pool generation by the parameterized convection in the RR may be overwritten by zero temperature tendency from the radar assimilation, significantly undermining cold pool generation. Single case study and cycled retrospective tests of this change will commence shortly.

Task 11.5.24 Develop, test, and improve the 3-km WRF-based High-Resolution Rapid Refresh

GSD
During this quarter, there was a significant coordinated research effort by several AMB scientists to test, evaluate, and implement changes to the HRRR system to address shortcomings noted during the 2010 CoSPA operational evaluation. This work included coded new solutions, conducting case study tests, evaluating them qualitatively

and statistically, then conducting several day retrospective tests (involving cycled runs of the RUC and RR models, in addition to the HRRR), and evaluating results qualitatively and quantitatively. Several elements were critical to this effort to quickly evaluate different configuration options. These elements include a fast, robust scale- and threshold dependent verification system, well designed real-time and parallel system run scripts, a rigorously maintained code version update repository, and an available computing resources provided by the HRRR shadow system. This work was conducted in an interactive manner with CoSPA partner organizations (NCAR/RAL and MIT/LL), with HRRR test grids made available for their evaluation.

Based on this testing and evaluation, several updates to the HRRR system have been made for the 2011 convective season, including: (1) switching from the use of RUC to Rapid Refresh grids to provide initial conditions for the HRRR (better overall convective evolution especially for CoSPA critical morning runs) (2) discontinuation of the 6th order diffusion option in the HRRR (improved treatment of southeast scattered convection), (3) specification of a larger temperature tendency, (4) elimination of previous code problems related to hydrometeor and moisture restoration in the RR radar-DFI procedure, (5) selection of a specific Thompson microphysics version to optimizes the size and intensity of storms, (6) inclusion of new observations and data quality-control procedures for the RR GSI-based assimilation system, and (7) numerous smaller changes to optimize various aspects of the system including reflectivity calculation, out file generation, and model run latency.

As a result of this research effort, these changes have been implemented in the real-time HRRR running at ESRL/GSD, including the switch to the use of the Rapid Refresh for initial conditions (change made on 14 April).

A comparison of 9-h forecasts from a HRRR based on the RR and the RUC versus the radar verification is shown in Fig. 9. Overall the RR-HRRR better depicts the arc of storms, especially across KS.

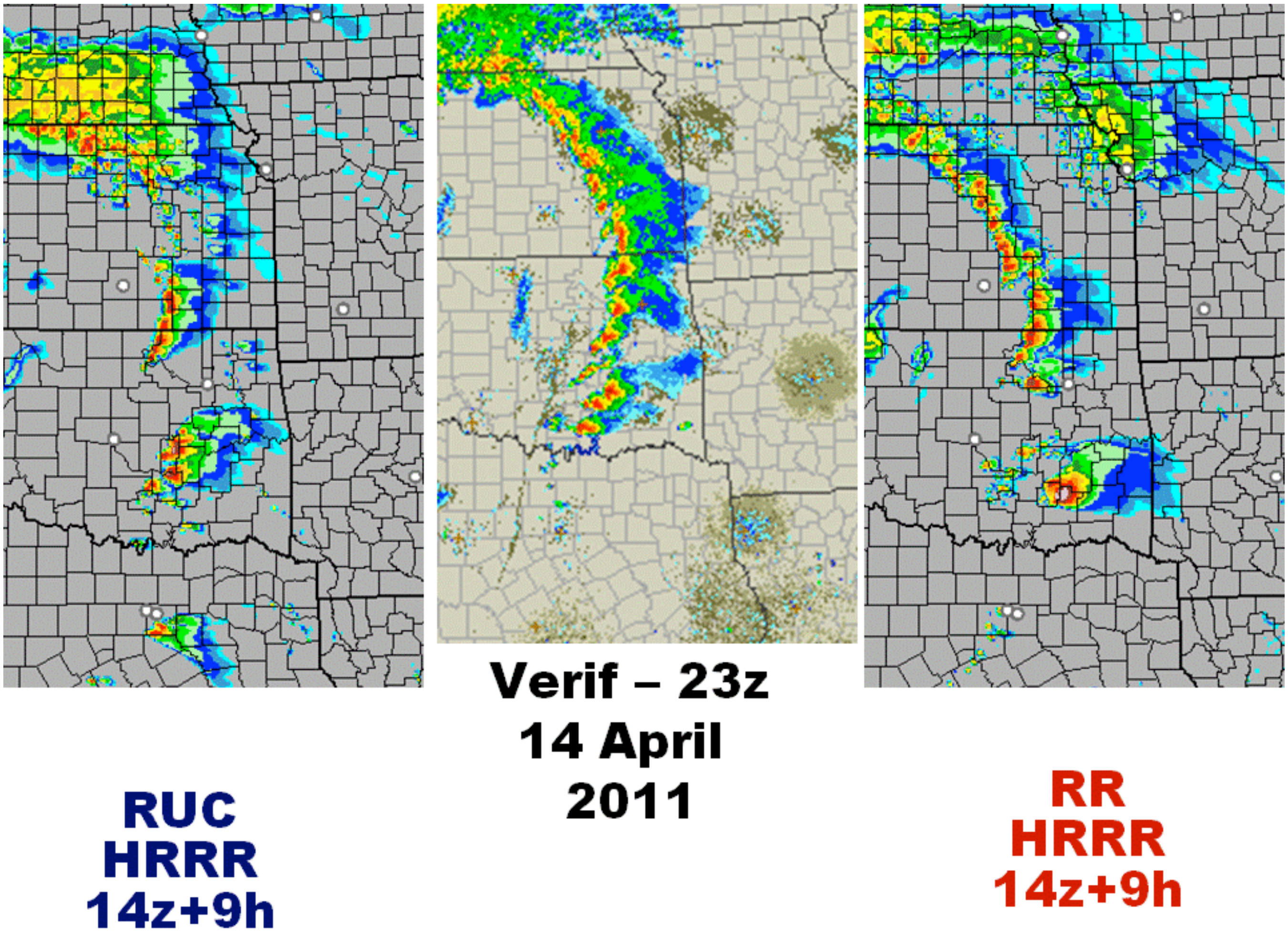


Fig. 9. Comparison of HRRR 9h forecast composite reflectivity field valid 23z 14 April 2011 initialized from the RUC (left panel) and the Rapid Refresh (right panel). The middle panel shows the observed radar reflectivity at 23z 14 April 2011.

In addition to these changes that were implemented, several other enhancements to address HRRR shortcomings documented in 2010, show promise and continue to be researched. These include especially 3-km radar assimilation, and improved treatment of the boundary layer in both the ARW model and in the radar assimilation (for both RR and HRRR). Tests of several variations on a non-cycled 3-km radar-DFI assimilation method were conducted, yielding some short-range improvement at the expense of modest long term forecast degradation. These experiments made use of a 3-km GSI version run over the entire HRRR domain, which will be a critical capability for future storm-scale data assimilation work. Based on these test, a cycled 3-km strategy is being coded and will be tested later this year. 3-km radar assimilation results were likely negatively impacted by the problem with the hydrometeor / moisture restoration. This problem has recently been solved and some of these experiments will likely be rerun as time allows.

Task 11.5.24 Evaluate convection-permitting forecasting by the ARW core for ultimate application in the HRRR

NCAR

CURRENT EFFORTS: NCAR began discussions with GSD for the collaboration to analyze high-resolution ARW runs and model performance for the HRRR. NCAR and GSD decided that NCAR will do its analyses on selected cases from the 2011 spring and summer convective seasons that are forecast with GSD's HRRR configuration. NCAR will do sensitivity testing to examine the performance of the ARWA for the HRRR.

PLANNED EFFORTS: In the next quarter NCAR will begin to review the real-time HRRR forecasts made for the 2011 convective season in conjunction with the SPC Spring Forecast Experiment. NCAR will collaborate with GSD to select cases from the real-time HRR forecasts for sensitivity testing and in-depth analysis. NCAR will then produce its own ARW simulations of the events using HRRR ICs and BCs. As indicated, NCAR will do ARW sensitivity testing and will analyze the suite of runs.

UPDATES TO SCHEDULE: NONE